BRIEFER ARTICLES

QUADRAT STUDIES IN A MOUNTAIN GRASSLAND

In connection with an extended study of dry grassland areas in the mountains of Colorado, the writer has examined a large number of meter square quadrats. A report[1] already published deals with 16 quadrats located at different stations in Boulder Park, Tolland, Colorado (altitude 8889 feet). In the present paper the vegetation is described for a series of 158 quadrats in the same park. These extend 138 m. in an east-west line, with an additional row of 20 running south from quadrat 45. The general slope is toward the west, with consequent exposure to prevailing winds.

Each quadrat was studied and recorded separately, according to the plan described in an earlier paper.[2] The records for all quadrats of each society were then added and averaged. Apparently this kind of work does not appeal to most ecologists, as I have found no published figures on xerophytic grasslands that could be used for comparison.

Six minor assemblages of plants are included in the quadrats studied. The list, together with the quadrat numbers, follows:

Xerophytic ridge (*Erigeron multifidus* society) 1–16
Xerophytic slope (*Muhlenbergia-Comandra* society) 37–76, 139–158
Xerophytic slope (*Muhlenbergia-Antennaria anaphaloides* society) 117–3
Xerophytic slope (*Muhlenbergia-Aragallus* society) 92–110
Hypoxerophytic slope (*Muhlenbergia-Danthonia* society) 32–36, 77–91, 127–138
Glacial sink 111–126

The systematic list which forms the chief part of this article is prepared from collections made in the midsummer of 1914; censuses were made at that time and verified in 1915. It will be seen that grasses form a large part of the vegetation, 18 species out of a total of 79. Sedges are not so important as is often the case in mountain grasslands or indeed as in other parts of the same park. There is an entire absence

[1] RAMALEY, F., The relative importance of different species in a mountain grassland. BOT. GAZ. **60**:154–157. 1915.

[2] ———, The amount of bare ground in some mountain grasslands. BOT. GAZ. **57**:526–528. 1914.

SYSTEMATIC LIST

	1 Erigeron multifidus (16 quadrats)	2 Muhlenbergia -Comandra (60 quadrats)	3 Muhlenbergia -Antennaria (15 quadrats)	4 Muhlenbergia -Aragallus (19 quadrats)	5 Muhlenbergia -Danthonia (32 quadrats)	6 Glacial sink (16 quadrats)	Average of 158 quadrats
Bare ground and rocks*	42.0	31.1	29.9	25.5	24.6	25.6	29.6
Parmelia molliuscula (lichen)*	1.0	1.0	0.6	1.0	0.5	.....	0.8
Selaginella densa*	11.3	2.9	2.0	3.4	2.3	1.5	3.5
Agropyron violaceum*	0.8	0.8	1.3	0.5	1.0	2.2	1.0
Agrostis hiemalis	.....	.....	.....	.....	0.3	1.5	0.1
Avena americana*	0.4	0.9	1.0	0.6	0.2	.....	0.6
Bromus Pumpellianus	.....	1.5	.....	.....	0.5	1.2	0.8
Danthonia intermedia	.....	0.1	0.2	.....	0.2	9.2	0.1
Danthonia Parryi*	0.9	1.7	3.1	4.8	6.4	0.2	2.9
Festuca ingrata	1.0	2.3	0.7	1.6	.....	.....	1.2
Festuca saximontana*	.....	5.4	11.1	1.6	11.9	7.8	5.9
Koeleria cristata*	5.4	3.8	5.0	6.7	4.6	0.5	4.3
Muhlenbergia gracilis*	3.4	11.4	0.6	14.8	8.6	11.8	9.8
Phleum alpinum	.....	.....	.....	.....	0.1	1.2	0.1
Poa pratensis and compressa	.....	.....	.....	.....	.....	1.0	0.1
Poa crocata	0.4	0.9	1.2	.....	0.4	.....	0.6
Poa interior*	0.4	0.7	0.1	1.4	2.0	.....	0.9
Poa rupicola	0.1	0.2	0.8	0.6	.....	.....	0.3
Poa subpurpurea	.....	.....	.....	.....	0.1	.....	0.1
Stipa comata	0.7	2.3	.....	0.1	0.1	.....	1.0
Stipa viridula	.....	.....	.....	.....	.....	3.8	0.4
Carex filifolia*	1.0	0.2	2.2	1.0	1.0	.....	0.5
Carex obtusata	.....	.....	.....	1.2	0.6	.....	0.3
Carex siccata	.....	.....	.....	.....	0.1	0.4	0.1
Carex stenophylla*	4.6	1.0	0.3	3.9	1.6	0.1	1.5
Juncus balticus montanus*	0.7	0.7	0.6	0.6	0.8	1.8	1.0
Allium recurvatum	1.0	.....	.....	.....	.....	.....	0.1
Comandra pallida	0.3	2.3	2.2	.....	.....	.....	1.1
Eriogonum subalpinum	.....	0.1	.....	.....	.....	0.1	0.1
Eriogonum umbellatum	.....	0.6	.....	0.1	.....	.....	0.1

SYSTEMATIC LIST—*Continued*

	1 Erigeron Multifidus (16 quadrats)	2 Muhlenbergia -Comandra (60 quadrats)	3 Muhlenbergia -Antennaria (15 quadrats)	4 Muhlenbergia -Aragallus (19 quadrats)	5 Muhlenbergia -Danthonia (32 quadrats)	6 Glacial sink (16 quadrats)	Average of 158 quadrats
Polygonum Engelmanni	.....	0.1	.....	.....	0.1	0.6	0.1
Chenopodium oblongifolium	.....	0.1	.....	.....	.....	.....	0.1
Arenaria Fendleri*	1.3	2.0	1.5	1.4	1.0	0.1	1.5
Cerastium occidentale*	0.7	1.5	3.0	1.4	3.0	0.6	1.7
Silene Hallii*	.....	0.2	0.3	0.2	0.8	0.1	0.1
Ranunculus cardiophyllus	.....	.....	.....	0.1	.....	0.1	0.1
Arabis divaricarpa	.....	0.1	.....	.....	.....	0.2	0.1
Erysimum Wheeleri	.....	0.1	.....	.....	0.1	.....	0.1
Thlaspi purpurascens	.....	0.2	0.1	.....	0.2	.....	0.1
Sedum stenopetalum*	1.1	1.0	1.0	0.7	1.3	0.2	1.0
Dasiphora fruticosa*	0.2	1.3	3.1	0.1	0.2	0.6	0.9
Potentilla concinna*	1.3	0.1	0.8	0.1	0.1	.....	0.2
Potentilla Hippiana*	0.1	0.1	0.3	0.7	0.4	0.6	0.3
Potentilla pennsylvanica strigosa	1.2	0.3	0.2	0.1	0.4	0.1	0.3
Potentilla pulcherrima	.....	.....	0.1	.....	0.1	0.2	0.1
Sieversia ciliata	.....	.....	0.4	.....	0.3	0.1	0.1
Aragallus deflexus	.....	0.3	0.2	1.8	0.8	.....	0.6
Aragallus Lambertii*	5.6	4.0	3.4	5.4	2.7	0.1	3.6
Aragallus Richardsonii	.....	0.1	.....	1.6	0.7	0.1	0.4
Thermopsis divaricarpa	0.1	.....	.....	.....	.....	.....	0.1
Pseudocymopterus tenuifolius*	.....	0.5	1.3	0.6	1.0	1.2	0.7
Vaccinium caespitosum	.....	.....	.....	.....	0.1	7.3	0.7
Androsace puberulenta*	.....	0.2	0.3	0.2	0.2	0.6	0.2
Amarella plebeja	.....	.....	0.1	.....	.....	0.1	0.1
Dasystephana Parryi*	.....	0.1	0.3	0.4	0.3	0.1	0.2
Mertensia Bakeri*	1.0	2.8	4.6	2.1	2.7	1.1	2.4
Orthocarpus luteus*	.....	0.3	0.1	2.1	0.6	0.1	0.5
Pentstemon procerus*	.....	0.1	0.2	0.2	0.8	6.7	0.9
Galium boreale	.....	0.2	0.1	.....	0.3	.....	0.1
Campanula petiolata*	.....	0.4	0.7	0.8	0.7	1.3	0.6

Achillaea lanulosa*	.....	0.7	2.0	0.9	0.2	3.0	1.2
Antennaria anaphaloides	0.2	0.7	3.0	.....	0.3	.....	0.6
Antennaria aprica and arida	.....	0.1	.....	1.2	0.6	0.3	0.3
Antennaria microphylla*	.....	0.5	0.5	0.5	2.0	0.3	0.6
Artemisia Forwoodii and aromatica*	2.0	1.1	1.3	1.6	1.2	0.2	1.2
Artemisia frigida*	3.0	4.7	3.8	4.1	3.0	0.5	3.7
Aster lonchophyllus	.....	.....	.....	.....	.....	0.2	0.1
Chrysopsis villosa*	2.5	3.3	3.3	2.1	2.0	0.5	2.5
Erigeron eximius	.....	.....	.....	0.1	0.1	0.4	0.1
Erigeron macranthus	.....	.....	0.2	.....	0.1	.....	0.1
Erigeron multifidus	5.0	.....	0.2	.....	.....	.....	0.5
Gaillardia aristata	.....	0.3	.....	.....	.....	.....	0.1
Solidago concinna	.....	.....	0.1	0.2	0.6	0.5	0.2
Agoseris glauca*	.....	0.4	0.3	0.5	0.9	0.4	0.3
Taraxacum Taraxacum	.....	.....	.....	.....	.....	0.2	0.1
Total	99.7	99.9	99.7	100.4	97.9	98.5	98.4

of such plains grasses as *Bulbilis* and *Bouteloua*. No cacti of any kind are found, although they are present in mountain parks at slightly lower altitudes. The large proportion of Papilionaceae and Carduaceae here noted is to be expected in any area of the Rocky Mountain region.

Many of the plants are recorded from all of the minor communities in the list; some from only a part. The species here noted include most of the common ones of xerophytic areas of higher parks, but only about one-half of the entire number of species in the dry grassland of Boulder Park.

The figures in the list are for percentages of ground covered. Amounts less than one-tenth of 1 per cent are given as 0.1 per cent. An asterisk (*) is placed after the names of species found in all or all but one of the different communities.

The water requirements of the several species will be understood best if the reader will keep in mind that the most xerophytic plant assemblage is represented in column 1, and that the other columns represent in order less and less arid conditions. Hence a plant shown only at the left of the table is hyperxerophytic, as *Poa rupicola* and *Allium recurvatum*. One recorded chiefly at the right is hypoxerophytic, as *Agrostis hiemalis* and *Stipa viridula*. It should be mentioned, however, that an occasional stray may get in anywhere, as *Thermopsis divaricarpa*, a meadow plant here recorded from the driest situation.—FRANCIS RAMALEY, *University of Colorado, Boulder, Colo.*